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Studies upon Akenes and Seedlings of Plants of the Order Compositæ.

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(Plates CXXXIV.—CXXXVIII.)

General Observations.

The fruit of the plants, belonging to the Order Compositæ is no less remarkable for its variety of external form than for its uniformity in internal structure. In the mature fruit, the calyx and the carpellary coats are completely combined, so that they cannot be distinguished by any structural differences. The integument of the seed may be separated from the others, and is a delicate polished membrane, wrapped rather closely around the embryo. The limb of the calyx, although sometimes obsolete (*Chrysanthemum Leucanthemum et. al.*) more often appears as a crown or cup (*Anthemis arvensis et. al.*) or a set of teeth or scales (*Helenium autumnale et. al.*) or as a tuft of bristles or hairs (*Aster et. al.*) When the limb of the calyx takes on any of these forms it is called the pappus. In *Lactuca*, *Taraxacum*, *et. al.*, the pappus is raised far above the akene by a prolongation of the calyx into a slender beak. The akene may be terete, striate, ribbed, angled, or winged. It may be glabrous, hairy, silky, or even spiny. It is usually larger above and tapering downward, but this is not always the case. There is more or less of an opening left at the base of the akene when it falls from the receptacle through which the hypocotyl emerges when the seed germinates. These are but a few of the general ways in which the akene varies externally. To enumerate all the variations would necessitate a description of every species.

The akene is one-celled, containing a single anatropous, exalbuminous seed with a straight embryo. The embryo conforms in shape and size to the enclosing walls. In *Bidens* and *Coreopsis* it is much flattened and narrows abruptly at the base; in *Eupatorium* and *Mikania* it is cylindrical; and in *Helianthus*, *Aster* and *Solidago* and many others it is top-shaped, the cotyledons filling the upper thicker portion of the akene, and these narrowed below into the still narrower hypocotyl. The cotyledons are usually longer and broader than the hypocotyl, but this is not always the case, (as asserted in Gray's Syn. Fl. of N. A., p. 48). In *Ambrosia* the hypocotyl is very small; in *Aster*, *Solidago*, and *Coreopsis* the hypocotyl is larger, but still is much shorter and narrower than the cotyledons; in *Eupatorium* and *Mikania* it is as long, or longer than the cotyledons, and is nearly, if not quite as broad. The plumule is minute, but may be seen in a vertical section of the seed. The cotyledons are closely applied to each other, their faces being in the same plane in which the seed is flattened.

Germination begins by the growth of the hypocotyl, and its first evidence is the protrusion of that organ through the aperture at the base of the akene. The cotyledons enlarge, sometimes splitting the akene and thereby emerging; sometimes, especially in those cases where the akene is small, withdrawing entirely, and leaving the akene a mere shell. Akenes planted out doors in autumn germinate promptly in the spring.

The seedling always has two cotyledons which are nearly or quite alike. They vary in size from an inch long in *Ambrosia trifida* and *Helianthus annuus* to minute in the *Artemisias* and *Chrysanthemums*. They are all the way from nearly sessile in *Chrysanthemum* and *Anthemis* to long-petioled in *Prenanthes* and *Arctium*. The bases of the petioles form a sheath around the plumule when the seedling is young. This sheath is widely dilated in *Anthemis*, but in most cases appears as a continuation of the hypocotyl. The cotyledons, although differing in some respects, display a striking uniformity throughout the order. They vary from spatulate to orbicular; in a majority of cases, however, being oblong. They are entire and usually narrowed abruptly into the petiole. The midvein is usually prominent, and may run to the apex or may fork somewhat below. In some species two

lateral veins follow the petiole, diverge at the base of the blade and ramify near the margins of the leaf. They and their branches reticulate with the branches of the midvein. When the lateral veins are not present the branches of the midvein reticulate with each other. The hypocotyl is of considerable length, sometimes slightly flattened. The tap-root, at first well marked, is sometimes lost among its fibrous branches, sometimes maintaining supremacy throughout.

In one species, at least, branches arise normally from the axils of the cotyledons (*Coreopsis discoidea*). In *Anthemis arvensis* branches arise, if not from the cotyledons, from the axils of the first leaves.

In some species the leaves, like the cotyledons, are opposite during the whole life of the plant. The remainder are of the two-fifths arrangement. The first internodes may not elongate; thus is brought about the radical leaved forms. The Phyllotaxy of these, however, may be detected by the sequence of development.

The leaves may immediately assume very nearly the form of the mature plant. This is the case in *Anthemis arvensis*. Usually, however, there is a gradual transition in the first leaves from the cotyledons to the leaves of the mature plant. In *Chrysanthemum Leucanthemum* the first leaves are neither like the cotyledons nor the succeeding leaves.

In general it may be said that the first leaves show a tendency to retain the form of the cotyledons, but have the texture of the later leaves.

The germination of the seeds of annuals and biennials is much more prompt than is the germination of seeds of perennials. A much larger percentage of seeds of the former germinate also. Their seedlings are larger and more capable of withstanding hardships.

Several of the perennial plants of the order flower the first year. *Helenium autumnale* and *Aster Novæ-Angliæ* are among these. The biennials store up food in their tap-root (*Arctium, et al.*), or in the branches of it (*Lactuca*). Their leaves during the first year are radical and are usually of large size.

Germination.

The lines of inquiry undertaken in connection with the germination of seeds were several. Before planting, the percentage

of apparently good seed matured by each species was noted. In this case fifty good seed were taken, and the number of unfilled seed found with them, be they more or less, was recorded.

Many fruits are provided with a pappus which serves a two-fold purpose. It acts as a parachute and thereby assists in the dissemination of the seed; further it causes the seed to alight pappus end up, acting like the feathered end of an arrow. Now the parts of the embryo are so arranged that when the seed alights in this manner the cotyledons are up and the hypocotyl down. Thus the parts are placed in the most advantageous position for germination.

The 50 apparently perfect seeds of each species were divided equally, and one-half were planted with the pappus down and one-half with the pappus up. The figures given in the 3d and 4th columns of the accompanying table show the number which germinated in each case.

In the 5th column is shown the number germinated up to June 23. None germinated during the following summer. The seeds were planted the previous autumn (Nov. 23).

Finally the morphology of the seedlings was studied in different stages of development, and the peculiarities recorded in descriptions and drawings.

The seeds of various plants of the Order were gathered, care being taken that they be free from other seeds. Seeds were selected from several vigorous plants some distance apart, where that was practicable. The seeds were then taken from the heads indiscriminately, and carefully examined for any external evidences of poorness, and then by slight pressure with a needle to see whether or not they were filled. From the observations, the following statements may be made.

The number of seeds which, from their general appearance, can be detected as poor, is very variable among different species. In *Aster Novæ-Angliæ* var. *roseus* and *Solidago serotina* the number was large. In *Sericocarpus asteroides*, there were 2½ poor seeds to every good one. Those which ranged from 1½ poor ones to every good one, were *Ambrosia trifida* and *Helenium autumnale*. Two species perfected all of their seeds. These were *Polymnia Canadensis* and *Arctium Lappa*. Of the other

species, eight perfected more and four less than one-half of the good seed.

Excluding *Aster Novæ-Angliæ* var. *roseus* and *Solidago serotina* (the poor seeds of which were only estimated), it was found that of the 17 remaining species, 1321 seeds were examined, 900 of which were good, and 471 or not quite 33 per cent. of the whole number were poor. The statements are all based upon a study of the seeds themselves before they were subjected to a test by germination. An estimate of the quality of seeds by a study of the external appearance of the seed itself must necessarily be uncertain, and is bound to overestimate the good seed. The test by germination on the other hand may not give the full value to the vitality of the seed, and can never overestimate the good seed contained. In column 5 is tabulated the number of seeds germinated of the 50 supposed to be good. Four of the 50 assorted or of the 80 unassorted seeds of *Aster Novæ-Angliæ* germinated. 5 per cent. of unassorted, 8 per cent. of assorted, is the rate of germination of this plant. Of the seeds of *Inula Helenium*, 45 germinated. This gives as its rate 70 per cent. of unassorted and 90 per cent. of assorted. The percentages of these and the other species are tabulated in columns 6 and 7.

Of the plants which may be considered as *persistent field weeds*, but two were grown. Their percentage of germination was very large, the first being the highest of all.

Arctium Lappa 78
Taraxacum officinale 19

The *way side and fence row weeds* in the order of their percentage of germination is as follows:

Inula Helenium 70
Heliopsis helianthoides 65
Lactuca spicata 55
Coreopsis discoidea 32
Ambrosia trifida 23
Eupatorium perfoliatum 16
Aster Novæ-Angliæ 5
Solidago serotina 1

The remainder, which may not be characterized as *weeds*, range as follows:

Cnicus muticus 33
Prenanthes Serpentaria 15
Helenium autumnale 13
Sericocarpus asteroides 4
Polymnia Canadensis 2
Gnaphalium obtusifolium 1
Senecio vulgaris 0
Aster Novæ-Angliæ var. roseus 1
Hieracium venosum 0

The general average is:

Persistent field weeds 49
Wayside and fence row weeds 33
Not weeds 8

This is direct evidence that the vitality of seeds of a species is a factor in determining the abundance of the plant and its ability to become a weed.

TABLE SHOWING THE VITALITY OF SEEDS.

SPECIES STUDIED.	Seed apparently perfect.	Seeds not filled.	25 seeds planted, pappus end down. No. germ.	25 seeds pappus end up. No. germ	Total number germinated.	Per cent. germination. Seed assorted.	Per cent. of germ. Seed unassorted.
Aster Novæ-Angliæ	50	30	1	3	4	8	5
Prenanthes Serpentaria	50	40	9	5	14	28	15
Eupatorium perfoliatum	50	29	6	6	12	24	16
Ambrosia trifida	50	63	13	13	26	52	23
Gnaphalium obtusifolium	50	15	1	0	1	2	1
Inula Helenium	50	15	21	24	45	90	70
Polymnia Canadensis	50	0	1	0	1	2	2
Arctium Lappa	50	0	19	20	39	78	78
Solidago serotina	50	Est.	7	13	20	40	1
Coreopsis discoidea	50	28	9	16	25	50	32
Senecio vulgaris	50	5	0	0	0	0	0
Heliopsis helianthoides	50	15	20	22	42	84	65
Sericocarpus asteroides	50	128	3	4	7	14	4
Helenium autumnale	50	70	8	8	16	32	13
Hieracium venosum	50	14	0	0	0	0	0
Taraxacum officinale	50	8	3	8	11	22	19
Cnicus muticus	50	8	11	8	19	38	53
Lactuca spicata	50	3	10	19	29	58	53
Aster Novæ-Angliæ var. *roseus*	50	Est.	7	9	16	32	1

Descriptions of Akenes and Seedlings.

Eupatorium perfoliatum, L. (Plate CXXXIV. A–D.) "Akene 5-angled destitute of intervening ribs." The outer wall minutely perforated, 2 mm. long, black, pappus as long as the akene,

of about 20 capillary bristles. Embryo small; hypocotyl as long as or longer than the cotyledons, terete as is the whole embryo when the cotyledons are placed face to face.*

The cotyledons of the seedling plant are small, orbicular, the blade bent at an angle with its petiole. Petiole evident, but not long. Hypocotyl short, tap-root branching early. The hypocotyl soon bears roots up to the very base of the cotyledons. All the internodes lengthen. Leaves opposite. The first, second and third pairs are less and less petioled; the fourth pair are clasping, and the succeeding pairs are more or less perfoliate. The first and second internodes, and the accompaning leaves are less hairy than the remainder of the plant. The third and succeeding pairs of leaves take on more or less of the rugose character of the later ones. They also resemble the leaves of the mature plant in form. The plant does not blossom the first year, but grows to a height of a foot or more.

Solidago serotina, Ait. (PLATE CXXXIV. E–H.) The akene in this species is 10-costate and somewhat hairy, about one and three-fourth mm. long and one-third mm. wide. The pappus is nearly twice as long as the akene. The cotyledons in the seed are longer than the hypocotyl. The embryo tapers toward the base.

In the seedling the cotyledons are rather small, obovate-spatulate, short-petioled, hypocotyl as long as or longer than the cotyledons. The tap-root is soon indistinguishable from the other roots. The first internode elongates but little. The succeeding are gradually longer. The first leaf resembles the cotyledons in shape, but is ciliate along the margin, while the cotyledons are not. The hairs forming the cilia are upon the margined petioles of all the early leaves. They are longest at the sheathing base of the petioles, and grow shorter toward the apex of the leaf. Along the margin of the leaf they form merely a roughness. The early leaves are only faintly triple nerved. The tap-root is soon lost

* The statement made in the "Synoptical Flora of North America," (p. 48), to the effect that the ovule becomes "an exalbuminous seed with a straight embryo, the inferior radicle (hypocotyl) shorter and narrower than the cotyledons" is erroneous. In several, if not all the *Eupatoriums* and in *Mikania scandens*, the hypocotyl is as long as or longer than the cotyledons, and nearly, if not quite as broad.

among the multitude of fibrous roots. During the first year's growth no flowers appeared. At the end of the season there was a decided tendency to multiply by underground shoots.

Sericocarpus asteroides (L.) B. S. P. (Plate CXXXIV. I. K. L.) Akene only slightly compressed, 2-nerved, very silky; hence the generic name; 2 mm. long, 1 mm. broad; pappus more than twice the length of the akene, unequal, ferruginous. Embryo in vertical section, obovate. Cotyledons three times as long as the hypocotyl.

The seedling has small cotyledons. These are elliptical, or nearly orbicular, and smooth, petioled. Hypocotyl short. Tap-root prominent. The first leaf assumes the general characteristics of the later leaves. They are hairy above, smooth below, and ciliate along the margin of the blade and petiole.

Aster Novæ-Angliæ, L., var. *roseus*, Gray. (Plate CXXXIV. M–P.) Akene compressed, hairy, 10-ribbed, ovate, one-half as long as the soft pappus. Embryo with flattened cotyledons more than twice the length of the abruptly downward tapering hypocotyl.

Seedling with short hypocotyl. Cotyledons orbicular, small, smooth, short petioled. First four or five leaves narrowed to a petiole. The later leaves clasping. They, as well as the stem, pubescent. First internodes lengthening only slightly; the later much longer. Roots appear on the hypocotyl, and the tap-root is soon lost among them. Both this plant and the type *Aster Novæ-Angliæ* blossom during the first year. The seedling of this variety differs in no respect from that of the species unless it be that the lower leaves are narrower, and the clasping ones more narrowed above the auricled base. It would be necessary to observe more specimens before setting this down as an established fact.

Inula Helenium, L. (Plate CXXXIV. R. S. T. U.) Akene linear, obtuse at base, obscurely four-sided, striate, crowned at the top with the united bases of the pappus hairs. Pappus long (8 mm.) straw color, widely spreading from the top of the akene. Embryo subcylindrical, cotyledons twice the length of the hypocotyl.

Seedling medium in size. Cotyledons oblong, more than twice as long as broad; short-petioled, smooth; hypocotyl short; tap-root long and becoming thickened early; the first two leaves

hairy, broader and longer petioled than the cotyledons. Although the leaves are of two-fifths arrangement, the first two twist sufficiently to stand nearly at right angles to the cotyledons. Internodes not elongated, hence the leaves appear in a rosette. The 3d and 4th leaves are obscurely sinuate-toothed, ovate, rugose, hairy, especially beneath. The succeeding ones are lance-elliptical, more conspicuously sinuate-toothed, long-petioled.

The plant shows no signs of flowering the first year. The tap-root thickens, however, preparatory to flowering the following year.

Helenium autumnale, L. (Plate CXXXIV. V. W. X.) Akene small, 8 or 10-costate, hairy, turbinate, crowned with the pappus which consists of 5 or 6 chaffy pointed scales about one-half as large as the akene.

Seedling mediocre, cotyledons oblong, about one-half as broad as long, short petioled. Hypocotyl longer than the cotyledons. Tap-root long, soon overtaken by the fibrous roots and lost among them. The seedlings resemble young plants of Ribgrass (*Plantago lanceolata*, L). The first and second leaves are elliptical and the succeeding are elliptical-lanceolate, 5-nerved, sparingly toothed. The plant is smooth throughout. The leaves although in a rosette, are evidently of the two-fifths arrangement. Seedlings flowered during the first year's growth.

Ambrosia trifida, L. (Plate CXXXV. A–F.) The "fruit" of this species consists not only of the akene as found in other composites, but is made up of the akene closely and completely in vested by the gamophyllous involucre. It is "nut-like," beaked at the top and crowned by five or six short spines in a single series below the beak. The embryo is large and oily, obpyriform. It has a caruncle-like appendage at the inferior end of the hypocotyl. The cotyledons are thick and large; the hypocotyl small and tapering abruptly downward.

The seedlings are large, equalling in size the seedlings of *Helianthus annuus*. The cotyledons are nearly orbicular, thick, reticulate veined, narrowed at base into a short sheathing petiole. The hypocotyl is long and slightly flattened. The tap-root maintains supremacy throughout the life of the plant. The many root-

lets given out at the junction of the tap-root and hypocotyl are followed by many similar ones from all parts of the primary root. The hypocotyl sometimes attains a length of two inches, but not often more than that. The cotyledons are at length borne on petioles as long as their blades. The first pair of leaves are obtuse, sometimes trifid, but more often only toothed. Sometimes one of the first pair of leaves will be trifid, the other not. The succeeding leaves are of the same nature as those of the mature plants. The leaves show a gradation from the rounded apex of the cotyledons to the acuminate final leaves. The plant is an annual.

Ambrosia artemisæfolia, L. The seeds and seedlings of this species differ from *A. trifida*, L, principally in size. The cotyledons, hypocotyl and root are less than one-half as large as the same parts in the larger plant. Another difference of much importance in determining the character of the plant, is the presence of buds in the axils of the lower leaves and cotyledons, and their early development into branches. Thus, early, is the diffuse nature of the plant determined. The buds of the lower axils, moreover, must be one of the characters by which the plant maintains its reputation as a persistent weed. The first pair of leaves are "trifid" or not; sometimes one is "trifid," the other not. The lobes of the leaves in *A. artemisæfolia* are more rounded than in *A. trifida* from the very first.

Xanthium Canadense, Mill. (Plate CXXXV. H–M.) There are two akenes contained within the bur-like involucre of each pistillate head. The akenes are plano-convex, the plane side toward the axis of the head. They are black, elliptical, and tipped with the long protruding, but withered style. The cotyledons of the embryo are slightly dissimilar, the one on the convex or outer side being somewhat thicker than the other. The hypocotyl is very short, not more than one-sixth the length of the cotyledons.

The seedling emerges from the bur in the same manner as the seedling of *Ambrosia*. Both akenes in a single head frequently germinate, usually not at the same time, however, so the seedlings will be at two stages of growth. The hypocotyl lengthens considerably. The conspicuous tap-root gives off numerous branches. The cotyledons are lanceolate, obtuse, somewhat narrowed at the

base, strongly triple nerved. The first two leaves are nearly opposite; the succeeding become more and more distinctly alternate until, as in the mature plant, they are of the alternate type.

Seedlings, before the first leaves develop, have the hypocotyl bent nearly at right angles, thus causing its upper part and the cotyledons to lie upon the surface of the ground. At this stage of their growth there is every indication that the plant will be prostrate. It very soon straightens up, however, and by the time the first leaves are fully developed it is entirely erect. How the plant has come to assume this peculiar habit it is difficult to see.

Anthemis arvensis, L. (Plate CXXXVI. D. E. F.) Akenes roughly ribbed, not flattened, "crowned with a very short slightly toothed margin in place of a pappus."

Seedling with nearly sessile oblong cotyledons. Hypocotyl comparatively long. Tap-root evident. First two leaves pinnate. The succeeding bipinnate. The change from cotyledons to lobed leaves is abrupt.

The plant is a winter annual, that is from a plant ripening in July, seeds germinate the same autumn and remain over winter as seedlings. *A. Cotula*, L. (May weed) is, on the other hand, a summer annual. It ripens its seeds in autumn, and these do not germinate until the following spring and early summer.

Chrysanthemum Leucanthemum, L. (Plate CXXXVI. A. B. C.) Akene small (2 mm. long by ¾ mm. wide) 8 to 15-costate. The costæ white, the intervening spaces black. Pappus none.

Cotyledons of seedlings small, short-petioled, the petioles united at the base into a short sheath; blade oblong, thick. First two leaves spatulate, entire, borne on petioles nearly as long as the blade. The later leaves are like the radical leaves of the mature plant. The first and second leaves in this species can hardly be said to be intermediate in form between the cotyledons and the succeeding leaves.

Achillea Millefolium, L. (Plate CXXXVI. G. H. J.) Akene obcompressed, margined, small. The margin white; pappus none.

Cotyledons small, nearly orbicular, closely sessile. First two leaves small, tridentate, or the second one with two pairs of lateral leaflets. Succeeding leaves like the leaves of the mature plant.

Artemisia Absinthium, L. (Plate CXXXVI. K. L, M.) Akene not flattened, obovate, smooth; pappus none.

Seedlings small. Cotyledons closely sessile, 2 mm, long by 1 mm. wide. First two leaves linear-oblong, thickish, entire. The third and frequently the fourth tridentate, the succeeding coarsely toothed, finally compound. These seedlings may be distinguished from those of *Achillea* by the second and third leaves being oblong, entire; and from *Chrysanthemum* by the third and fourth leaves being tridentate.

Heliopsis helianthoides (L.) B. S. P. (Plate CXXXVII. L–O.) Akene without pappus, 3 or 4 angled [Triangular in the ray (Syn. F. of N. A.)]. Embryo only slightly flattened.

Seedling of medium size. Cotyledons bent at the union of the blade and petiole, blade nearly orbicular, petioles as long as their blade. Leaves opposite, the first pair ovate-lanceolate. They and the succeeding minutely hairy, scabrous above, smooth below; the later pairs ovate, somewhat toothed. The stems of seedlings have two pubescent lines running from the axil of each leaf to the next node above. The lines like the pairs of leaves decussate, those of any internode being half way round the stem from the lines of the internode below or above. The plant produced a few flowers during the first year's growth.

Helianthus divaricatus, L. (Plate CXXXVII. E. F. G.) Seedlings of this species differ very much in appearance from those of the common sunflower (*H. annuus*). They are slightly hairy, small and slow of growth. The akene is top-shaped, smooth. Hypocotyl of embryo short and narrower than the cotyledons.

Seedlings with short petioled cotyledons. These are ovate and thick. The first internode elongates. First pair of leaves elliptical, sessile, ciliate, veiny. The seedlings of this plant differ from those of *Heliopsis* in the shape of the cotyledons, length of their petioles, and in having the stem uniformly hairy instead of hairy in lines as is so conspicuously the case in *Heliopsis*.

Coreopsis discoidea, Torr. and Gray. (Plate CXXXVII. H–K.) Akene much flattened with 2, 3 or 4 upwardly barbed awns at the summit, somewhat hairy; embryo much flattened; cotyledons oblong, twice as long as broad, narrowed rather abruptly at the base into the short slender hypocotyl.

The seedlings of this species and of *Ambrosia* germinated very promptly in the spring. The cotyledons are oblong, petioled. Hypocotyl long, bearing a few roots at its union with the tap-root. Branches developed from the axils of the cotyledons as well as the succeeding leaves, thus early determining the diffuse character of the mature plant. The first pair of leaves sparingly toothed, longer petioled than the cotyledons. The later leaves longer petioled and less sparingly toothed. The plant is an annual.

Cnicus arvensis (L.) Hoffm. (Plates CXXXVII. B. C. D.) Seeds are not produced in abundance in the vicinity of Ithaca, yet by a little search plenty can be found. They have a long plumose pappus, are smooth and only obscurely angled.

The seedlings with which this obnoxious weed begins its life history are innocent-appearing enough. The cotyledons although very like those of *C. lanceolatus and C. muticus* are very small. The first leaf is spiny on the margin, the succeedings ones becoming larger and more spiny. Roots are given off throughout the length of the hypocotyl. The cotyledons have no prominent mid-rib; they are ovate, fleshy and obscurely reticulate-nerved. The early leaves are in a rosette.

Arctium Lappa, L. (Plate CXXXVIII. A–F.) The akene of the Burdock is flattened parallel to the faces of the cotyledons. The pappus is about one-half its length and is deciduous. It is black and blistered. The hypocotyl in the seed is very short; the cotyledons are large, filling the greater part of the seed.

The seedling is rather large, and, like the mature plant, very tenacious of life. The hypocotyl is short, only about one-fourth the length of the tap-root, and one-half as long as the cotyledons. Prior to the development of leaves from the plumule, the tap-root branches very sparingly, and mostly at the point of union of root and hypocotyl. It evinces a disposition from the first to become thickened. The cotyledons are sheathing at the base, fleshy, oblong-spatulate, obscurely emarginate, pinnately nerved, the lateral nerves visible only after the tissue has been cleared by soaking in alcohol. Plumule not developed sufficiently to protrude from the sheathing bases of the cotyledons. The seedling even at this early stage emits the peculiar odor of the mature plant.

The first leaf is intermediate in form between the cotyledons and the mature leaves. It is ovate, obtuse, truncate or subcordate at base, sparingly denticulate. The petiole is nearly or quite as long as the leaf. The succeeding leaves are cordate, denticulate, pinnately veined. The plant is strictly biennial. During the first year there is no elongation of internodes, consequently the leaves are all radical. The tap-root thickens and elongates, but at no time is it profusely branched. The hypocotyl disappears, and the tap-root appears to extend up to the bases of the leaves.

Cnicus muticus (Michx.) Pursh. (Plate CXXXVIII. G–K.) The akene is dark-colored, obovate and smooth; pappus long-plumose. The cotyledons and very small hypocotyl are oily in the seed.

The cotyledons, when developed, are obovate, entire, rounded at the apex, tapering toward the base, reticulately veined, with well-marked mid-rib. Hypocotyl short; tap-root long, only slightly branched.

The first leaves are hairy on both sides, and, like the mature plant, bear prickles along their margins. The succeeding leaves take on more and more the runcinate character of the radical leaves of the mature plant. During the first year's growth the internodes do not elongate. The tap-root thickens and branches considerably.

Taraxacum officinale, Web. (Plate CXXXVIII. L–O.) The fruit of the Dandelion consists of three parts, the akene, the beak and the pappus. The beak is for the most part a growth which takes place after the flower has withered. The akene is short, spiny above, obovate, somewhat flattened in the plane of the faces of the cotyledons. The hypocotyl is terete, about one-third the length of the cotyledons. The latter are one-half as wide as long, and when placed face to face, as in the akene, they are sub-cylindrical.

In the seedling the cotyledons are small (5 to 8 mm.), obovate-spatulate, apex rounded. The hypocotyl is as long as the cotyledons; tap-root long, somewhat branched. The first leaves are sinuately toothed. Only the later take on the "dens de leonis" character. The tap-root thickens and branches, but retains supremacy during the life of the plant.

The plant does not blossom the first year. Several leaves appear, but in the seedlings grown there is no indication of a flowering scape. As is well-known, there is never any elongation of internodes in this species.

Prenanthes Serpentaria, Pursh. (Plate CXXXVIII. W. X. Y. Z.) Pappus straw-colored, spreading horizontally from the top of the akene at maturity. The akene awl-shaped, slightly flattened, dark brown. The cotyledons six times the length of the hypocotyl.

The cotyledons of the seedlings are raised upon petioles longer than their blades.* The blade is spatulate, bent at right angles with the petiole at their junction. The petioles unite at their base to form a sheath around the plumule. The hypocotyl is shorter than it appears to be on account of the united bases of the cotyledons appearing as its upper end. Tap-root prominent, not diffusely branched. First and second leaves, long-petioled. Petioles red, not margined. Blade broadly ovate, slightly lobed or toothed. Third and succeeding leaves deltoid as are the radical ones of the mature plant.

Prenanthes alba, L. Like the preceeding species except in the seedlings grown the several parts were smaller and less in clined to be colored.

Lactuca spicata (L.) Hitchc. (Plate CXXXVIII. P–V.) Fruit not beaked, differing in this respect from some of the species of this genus. Pappus one and a half times the length of the akene, dirty white, of about 30 capillary bristles. Akene flattened and ribbed. Seen from the side it is ovate-elliptical; from the edge, lunate. The embryo, in conformity with the seed, is much flattened, obovate; the cotyledons are three or four times the length of the hypocotyl.

The seedling is small; cotyledons elliptical, sparingly hairy, reticulately veined; hypocotyl short, one-half the length of the cotyledons; tap-root branching early.

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*I have in my possession a seedling plant of this species which has the petioles of the cotyledons united up to the blade on one side. The close cohesion of the lower portions of the cotyledons in the seed seems to indicate that this might often occur.

W. W. R.

The first leaf is strikingly different from the cotyledons. It is petioled, the petiole wing-margined, nearly or quite as long as the blade. Blade orbicular, entire, erect, roughish. The second leaf petioled like the first, the blade broadly ovate, sinuate-toothed, subcordate, pinnately veined. The third leaf toothed along the margined petiole, and the succeeding leaves becoming more and more runcinate. The tap-root is branched, it and its branches become fleshy-thickened during the first year's growth. The plant does not blossom during its first year's growth. It is strictly biennial.

Abbreviations Used in the Plates.

c. cotyledons.
h. hypocotyl.
r^1. tap-root.
r^2. branches of tap-root.
pl. plumule.
p. pappus.

l^1, l^2, l^3, etc., first, second, third, etc., leaves. I prefer to call the first leaf above the cotyledons the "first leaf" and let the cotyledons retain their special name.

Plate CXXXIV.

Eupatorium perfoliatum, L.

A. Seedling from which the cotyledons have fallen (x 2). B. Younger seedling with cotyledons (x 2). C. Fruit (x 10). D. Embryo removed from coats (x 10).

Solidago serotina, Ait.

E. Seedling (x 2) with cotyledons and first three leaves developed. F. Same still more developed (nat. size). G. Akene (x 10) with pappus. H. Vert. sect. of same (x 10).

Sericocarpus asteroides (L.) B. S. P.

I. Akene (x 10) with pappus. K. Vert. sect. of same (x 10). L. Seedling with first three leaves developed (x 2).

Aster Novæ-Angliæ, L. var. *roseus*, Gray.

M. Akene (x 5). N. Vert. sect. of same. O. Seedling with first two leaves (x 2). P. Same older (x 2).

Inula Helenium, L.

R. Akene (x 10). S. Seedling (x 2). T. and U. Same in later stages T. (x 1½), U. (nat. size).

Helenium autumnale, L.

V. Akene (x 10) with chaffy pappus p. W. Seedling (x 2). X. Same older (x 2).

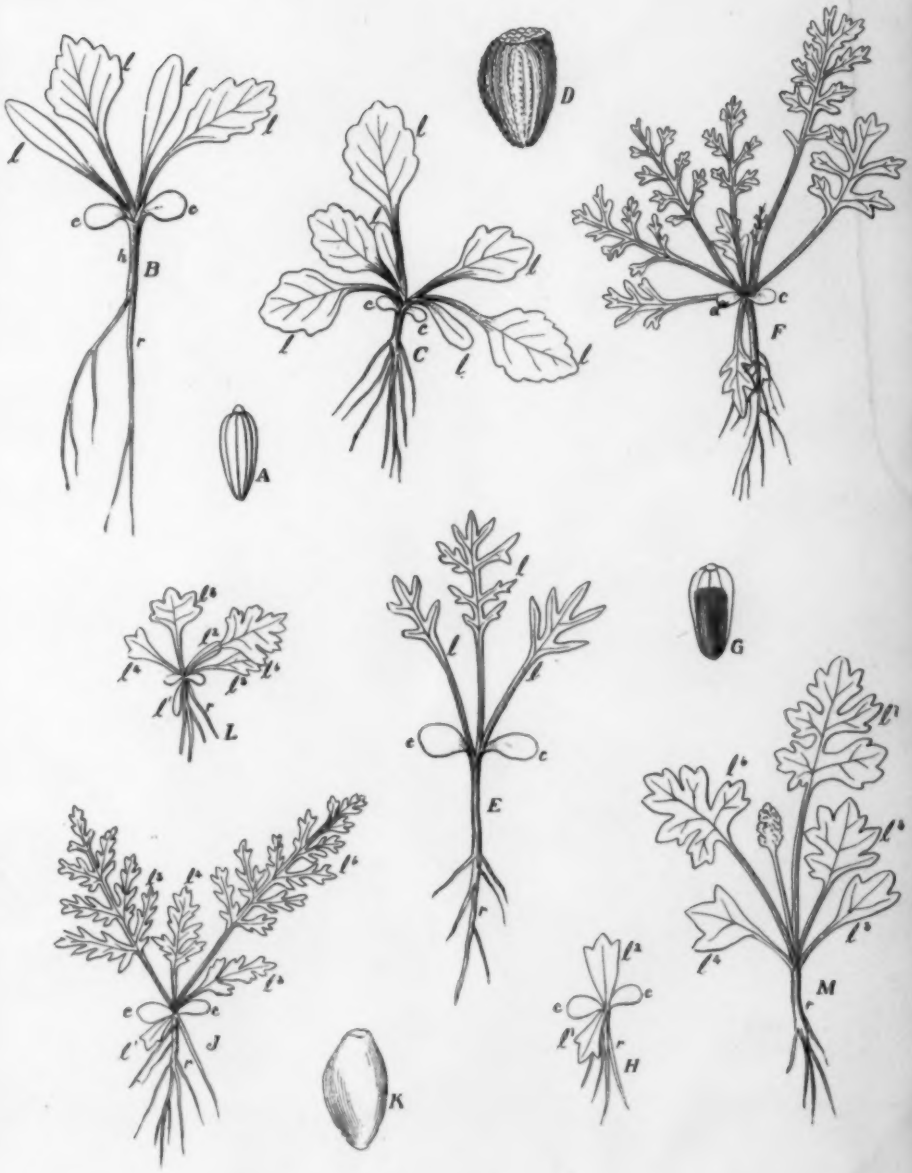
Plate CXXXV.

Ambrosia trifida, L.

A. The nut-like fruit (x 4). B. The akene with involucre removed. C. The seed with the ovary coats removed. D. The embryo. E. Seedlings with cotyledons fully developed. F. An older seedling. E. and F. nat. size.

AKENES AND SEEDLINGS OF COMPOSITÆ.

AKENES AND SEEDLINGS OF COMPOSITÆ.



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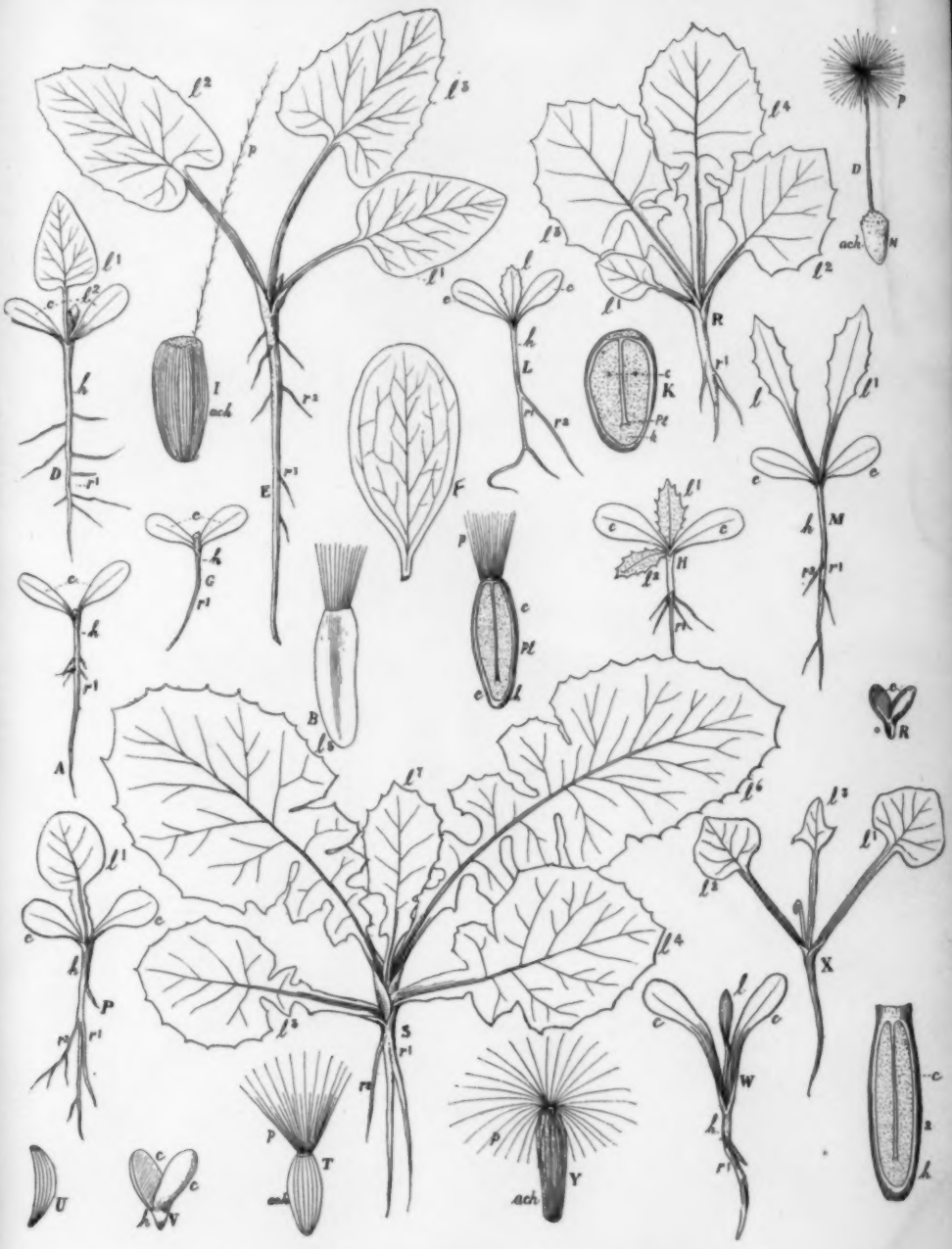

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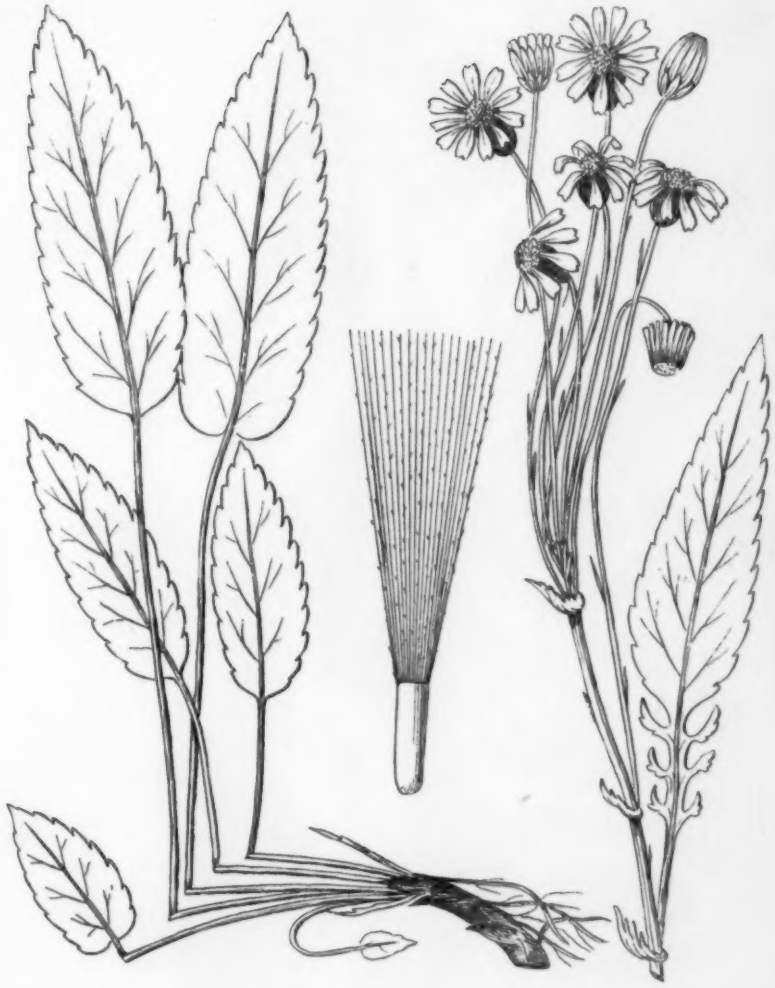

SENECIO ROBBINSII, OAKES.

Xanthium Canadense, Mill.

G. Fruit with hooked prickles (x 2). H. Akene from side and edge. J. Cross sect. of cotyledons. K. Vertical sect. of same. L. Seedling. M. Same older. L. and M. nat. size.

Plate CXXXVI.

Chrysanthemum Leucanthemum, L.

A. Akene (x 8). B. Seedling (x 3). C. Same, older (nat. size).

Anthemis arvensis, L.

D. Akene (x 10). E. Seedling with first three leaves (x 2). F. Same, older (nat. size).

Achillea Millefolium, L.

G. Akene (x 10). H. Seedling (x 5). J. Same, older (x 5).

Artemisia Absinthium, L.

K. Akene (x 12) L. Seedling (x 3). M. Same, older (x 5).

Plate CXXXVII.

Cnicus arvensis (L.) Hoffm.

A. Akene (x 10). B. Embryo (x 10). C. Seedling (x 5). D. Same older.

Helianthus divaricatus, L.

E. Akene (x 3). F. Embryo (x 3). G. Seedling (nat. size).

Coreopsis discoidea, Torr. and Gr.

H. Akene (x 6). I. Embryo removed from coats (x 8). J. Seedling (x 2). K. Same older (nat. size).

Heliopsis helianthoides (L.) B. S. P.

L. Akene (x 5). M. Young seedling (x 2). N. Same older (nat. size). O. Internode of stem with two pubescent lines running from the axil of the leaf to the point (on the next node above,) between the bases of the leaves.

Plate CXXXVIII.

Arctium Lappa, L.

A. Seedling with cotyledons fully developed. B. Akene (x 3). C. Vertical section of akene. (x 3). D. Seedling with first leaf developed. E. Seedling with first three leaves developed. F. Cotyledon (x 5).

Cnicus muticus (Michx.) Pursh.

G. Seedling with cotyledons fully developed. H. Seedling with first two leaves l^1 and l^2 developed I. Akene (x 5). K. Vertical section of same.

Taraxacum officinale, Web.

L. Seedling (x 2) with cotyledons fully developed. M. Later stage of same with first two leaves l^1 l^2 developed. N. Akene (x 4). p. beak. O. Embryo (x 6) removed from its coats and with cotyledons spread apart.

Lactuca spicata (Lam.) Hitch.

P. R. and S. successive stages in the devolopment of seedling. S. Magnified three times the others natural size. T. Akene. U. Same (edge) (x 5). V. Embryo removed from coats (x 5).

Prenanthes Serpentaria, Pursh.

W. Seedling (x 3) X. Same at later stage (nat. size). L. Akene (x 5). Z. Vertica sect. of akene (x 7).

Asplenium Bradleyi, Eaton.

For some time I have been interested in the relationship of *Asplenium Bradleyi*, and the note by Mr. Middleton in a recent number of the BULLETIN has given me fresh zest in the matter.

During the summer of 1890 this rare fern was discovered by Mr. J. K. Small, on Eozoic rocks near the junction of the Tucquan Creek with the Susquehanna river, about eighteen miles from Lancaster. Last February we visited that place, and within a quarter of a mile of the original station found two more locations for it. On October 15, Miss E. Gertrude Halbach and myself discovered another station at McCall's Ferry, two miles further down the river.

As to its relationship with *A. viride*, I do not see how it can possibly be referred to that species, of which I have at hand three specimens, one from Owen Sound, Ontario, Canada, and two from Smuggler's Notch, Vermont. In these specimens the pinnae are more or less rounded, and the fruit dots crowded on the lower side toward the rachis. The pinnae, furthermore, are only two or three lines long and almost as broad, while the stipes are green, except near the base.

The pinnae of *A. Bradleyi* are very rarely inclined to be rounded, even in the smallest specimens that I have seen, one from Northwest Arkansas, collected by F. L. Harvey, one from Estill county, Kentucky, collected by John Williamson, but are considerably longer than broad, some of them oblong-lanceolate, and others hastate, and almost an inch long on large specimens. As indicated in the last edition of Gray's Manual the pinnae are more or less auricled, a feature which is not possessed by *A. viride*, as far as I have been able to learn.

The sori are pretty evenly distributed toward the centre of the pinnae, and extend almost to the apex. The stipe, in the what we may call typical specimens, is usually brown until within a short distance of the apex. In others the brown extends half way or even somewhat less, but there is always considerably more of it than in *A. viride*.

Its relationship, as shown by specimens from this county, suggests a connection which I have never yet heard of from any quarter, but which I think is worth investigating. It seems to

stand close to both *A. montanum* and *A. pinnatifidum*. One specimen, nine inches high from the Tucquan, is not easily distinguished from a pinnate form of *A. pinnatifidum*, which is somewhat of a novelty and rather scarce. I am sometimes inclined to think that it is a good variety, if not a species. If it were not for a little frond at the base, which proves beyond a doubt that it is *A. Bradleyi*, I would not know where to place the above-mentioned specimen. Besides the large, as well as some of the small forms, have the tapering projection, which is a feature of both *A. pinnatifidum* and *A. montanum*, and, as with them, is sprinkled with fruit dots to the very end.

One large specimen from McCall's Ferry resembles *A. montanum* very much. At both stations *A. Bradleyi* is associated with *A. montanum* and *A. pinnatifidum*. Are the three found in company at other places?

The dissimilarity in character, both as described in the Manual and by comparison with material at hand, completely debars *A. Bradleyi* from being a variety of *A. viride*. Further exploration of the river hills will undoubtedly bring more of it to light, and there certainly is more of it between this part of Pennsylvania and Kentucky. More specimens from different localities will give us wider views on the subject.

In this connection it may be of interest to state that on November 30th I discovered *Pinus pungens* at McCall's Ferry. It is quite plentiful, and seems to be the prevailing pine.

A. A. HELLER.

LANCASTER, PA., December 7, 1892.

Senecio Robbinsii, Oakes.

BY H. H. RUSBY.

(PLATE CXXXIX.)

Senecio Robbinsii, Oakes, Ms. in Herb. Columb. Coll. *S. aureus*, var *Robbinsii*, A. Gray, in Herb. Columb. Coll. *S. aureus*, var. *lanceolatus*, Oakes, Hovey's Mag. May, 1841, and Thompson's Gazetteer of Vermont; T. & G. Fl. N. A., ii. 492, not *S. lanceolatus*, T. & G. *S. aureus*, var. *Balsamitæ*, T. & G. form of, Gray Syn. Fl. i. part 2, page 391.

From an oblique rhizome, erect, very slender, 2 or 3 feet high,

glabrous. Root-leaves 3 to 6, occasionally more, erect on very slender petioles 4′ to 8′ long, the blade 1½′ to 3′ in length by ½′ to 1¼′ in breadth, lance-oblong, acute or obtusish, the base short-cuneate to sub-cordate, sharply and unequally serrate; the cauline sessile and partly clasping, but some apparently petioled by the intervention of a more or less long, naked portion of the mid-rib, serrate above, below laciniate toothed, to distantly lacinately lobed. Heads mostly 8 to 12, on long, sometimes very long, slender peduncles, ⅜′ high; scales lance-linear acutish two-thirds as long as the disk-flowers; akenes linear-oblong, sharply ribbed.

Occurring in wet meadows and bogs along the border of woods or in otherwise partly shaded situations, Northern New England, New York, also in North Carolina. Collected by Robbins at Brownington, Vt.; T. G. White at Franconia, N. H.; Mrs. Clark and Dr. Britton, near Mt. Marcy, in the Adirondacks; Rusby and others at Willoughby, Vt.; and by Messrs. Small and Heller on Roan Mountain, North Carolina.

It is a little strange that this fine species of *Senecio* has so long escaped publication as a species. It is probably due to the fact that the comparatively few botanists of the past generation who have dared say what they thought, never saw it in a growing state. In the herbarium it is not difficult to mistake it for *S. aureus*, but not so when seen growing. During the past season it was almost simultaneously discovered by Dr. Britton and myself, and each of us at once resolved to describe it as a species. Mr. Oakes, who first described it from Robbins' specimen as a variety, had a strong feeling that it was distinct, and wrote on the label, "If this is a new species I should be glad to have it called S. Robbinsii." Out of deference to Mr. Oakes, I give him credit for the species. Upon the same sheet, Dr. Gray writes, "S. aureus, var. Robbinsii (An Sp. Nov.?)," but in later years, misled by its great resemblance to *S. aureus*, he assigns it to a very insignificant position.

Botanical Notes.

A Century of Weed Seeds.—Professor Byron D. Halsted, of the New Jersey Agricultural Experiment Station, New Brunswick, has supplemented his distributed sets of 100 American weeds by sets of their seeds. They are arranged in vials with printed

labels, placed in a tray about the size of an herbarium sheet. Botanists generally should be interested in this collection, prepared especially for use at the Agricultural Experiment Stations, where it will prove invaluable in the determination of seeds. A few sets of the collection may be had from Professor Halsted at $10 each.

In my note on Polypodium vulgare var. Cambricum, in the September BULLETIN, I stated that it was its first recorded station in America. In this I was in error, as Dr. T. J. W. Burgess had already noted in 1886 (Trans. Royal Soc. Canada, iv., 10), the finding of this variety at Port Simpson, British Columbia, near the southern extremity of Alaska. I had entirely overlooked this reference, although Dr. Burgess had kindly sent me a copy of his paper when published. LUCIEN M. UNDERWOOD.

GREENCASTLE, IND., October 31, 1892.

Sur la Conservation des Herbiers.—Alfred Chabert (Bull. Soc. Bot. France, xiv., 156). Various more or less laborious methods for the preservation of plants in herbaria are discussed at length. Among others it is noted that paper manufactured solely of vegetable matter and unbleached, notably that made of wood fibre is especially valuable for preventing the ravages of insects, though it is neither as white nor as smooth as might be wished for. It is suggested that it might be desirable to use alum in the manufacture of herbarium paper as a preventative of insect life. The author concludes, however, that one of the most efficacious, least expensive and least time-consuming of processes for the complete extermination of herbarium pests is a semi-yearly fumigation with sulphur. A. M. V.

Pink Water Lilies.—An interesting fact concerning *Castalia odorata*, f. *rosea* (Pursh.) Britt., has just been brought to my notice. On a plat of low bottom land near Buffalo, Putnam Co., W. Va., the plough turns up a large number of small tubers each season that the soil is cultivated. These planted in tubs produce, much to the astonishment of the neighborhood, beautiful deep-pink water-lilies. How long this bottom has been drained is not known, but the evidence adduced by the fact above stated of the existence of a pond here, certainly over a century ago, is very in-

teresting; as is also the light thrown upon the distribution of this pretty form of the water-lily. C. F. MILLSPAUGH.

Notes on Scabiosa australis and Reseda alba. Referring to Mr. Redfield's note in the BULLETIN regarding *Scabiosa australis*, Wulf., I think it may be of interest to report an additional station for it. I found it September 27, 1889, at Lisle, Broome county, N. Y., perhaps twenty or thirty rods south of the D. L. &. W. Station, on the east side of the track, on the railroad ground, where it was well established, having taken entire possession of the ground for several rods, and in two or three different patches. I have noticed it several times since as I was passing on the train, the last time being only three weeks ago, and it seems to be still spreading. On the date above mentioned I sent some of it to Dr. Watson, and under date of September 30th he writes: "It is naturalized in several places in central New York and Pennsylvania and perhaps should go into the Manual." I have thought sometimes that my calling attention to it just before the issuing of the Manual was the reason it appeared in the appendix.

I found in June, 1890, *Reseda alba*, L., growing by the side of the street in Youngstown, O. As it is not a plant that any one would cultivate for either its beauty or its fragrance, I could not consider it an escape from a garden, and wondered how it got there. There were a dozen or more plants, but I have not had opportunity since to learn if it persists in the same place or not; I will try and learn next summer. Has it been reported before?

R. H. INGHAM.

NILES, OHIO, Nov. 24, 1892.

[*Reseda alba*, L. is reported in Mr. David F. Day's Catalogue of the Plants of Buffalo, N. Y., as "spontaneous in gardens and escaping."—ED.]

Proceedings of the Club.

WEDNESDAY, NOVEMBER 30TH, 1892.

The President in the chair and thirty-six persons present.

Dr. Britton reported a communication from E. W. McCabe to the effect that the late Miss Phœbe McCabe had expressed a wish that upon her death her herbarium should pass into the possession of the Club, for which she had always entertained a deep regard. Dr. Britton remarked upon the energy with which she had collected

the flora of the region about White Plains, N. Y. It was unanimously resolved to accept the collection.

The following were elected active members: Miss Emma J. Thompson, Dr. O. G. Harrison, Mr. C. C. Curtiss, Miss Effie A. Southworth, Miss Jean K. Howell, Miss Theresa Gertrude Williamson, Miss Helen M. Ingersoll and Mr. Frank A. Pollard.

The first paper of the evening, entitled "The Flora of Willoughby Lake and Mountain," was then read by Dr. Rusby. The paper was illustrated by a number of lantern views.

The President remarked that the paper was very interesting in its reference to new forms. Dr. Britton said that the reference to *Campanula rotundifolia* recalled his observations in New York and elsewhere that this species grew not alone on rocky banks, but in meadows. Dr. Rusby replied that this was true to a limited extent at Willoughby, and that the banks upon which it grew were themselves grassy. Miss Kellogg confirmed this statement. Mrs. Britton stated that along the Intercolonial Railway in Nova Scotia she had noticed plants three feet high growing in thick grass.

The second paper, entitled "The Seeds of Some Native Orchids," illustrated by drawings and microscope slides, was then read by Mr. Carlton C. Curtiss.

TUESDAY, DECEMBER 13, 1892.

Dr. Brtiton announced to the Club the death of Dr. John S. Newberry, for many years president of the Club, which took place on December 7th, after a prolonged illness. Dr. Britton remarked on the invaluable services rendered to botanical science by Dr. Newberry. A committee consisting of the president, Dr. Allen and Dr Britton was appointed to prepare an account of his life and works for publication in the BULLETIN.

Miss Helen Desmond Nelson was elected an active member and Prof. George B. Aiton, of Minneapolis, Minn., a corresponding member.

Reading of communications followed, the first being a paper by Dr. Emily L. Gregory, entitled. "Notes on *Riccia*." Some valuable additions were made to our knowledge of the history of

R. natans. The paper was illustrated by blackboard drawings and by specimens preserved in alcohol.

The second paper was then read by Dr. N. L. Britton and was entitled, "Notes on some Interesting Plants of the Adirondack Mountains," illustrated by copious specimens. The president remarked upon the evidence presented by this paper of the great importance of carefully exploring well-known localities. Every such exploration, of which an account has been presented to the Club, had resulted in bringing to light new facts of importance. Dr. Britton then read a short paper "On *Rusbya*, a new Genus of Vacciniaceæ from Bolivia." The paper was illustrated by specimens of two species, as well as by a number of other interesting members of this family from the same region. Special interest centered in the question as to whether these plants were really parasitical or not. Dr. Rusby was called upon for some remarks, and expressed the opinion that they were, at most, only partially parasitic. As he had observed these plants growing in the Bolivian Andes, it seemed to him that the group presented indications of being but the remains of a very large group which had formerly existed. Species in the several genera were in a number of cases solitary or few, and other cases showed broad gaps. He had a number of new species and probably a new genus waiting to be described.

WEDNESDAY, DECEMBER 28, 1892.

The president in the chair and nineteen persons present.

Dr. Britton exhibited a large work in two volumes on "Seedlings" by Sir John Lubbock, and remarked upon the importance of the subject and the value of the book.

Miss May Bristol was elected an active member.

The announcement paper of the evening, on "Hostile Bacteria," was then read by Prof. H. W. Conn, of Wesleyan University.

Recent Literature Relating to American Botany.

Additions to the Cretaceous Flora of Staten Island. Arthur Hollick. (Proc. Nat. Sci. Assoc. Staten Island, November, 1892.)

Additions to the Flora of the Cape Region of Baja California. T. S. Brandegee. (Proc. Calif. Acad. Sci. (II.) iii. 218, reprint.

Four species are described as new: *Dalea trochilina, Acacia Californica, Albizzia accidentalis* and *Dianthera incerta.*

A Double Morning Glory. (Gard. and For. v. 592.) With illustration of double flowers of *Ipomœa purpurea.*

Araceen Brasiliens—Die Nutzbaren und Officinellen—Theodor Peckholt. (Pharm. Rundsch. x. 279.)

Aster and Solidago—Development of the Flower and Embryo-Sac in. G. W. Martin. (Bot. Gaz. xvii. 406; with plates.)

Aster and Solidago—Development of the Floral Organs in. George Martin. (Am. Nat. xxvi. 1032.)

Botanical Notes from Texas. E. N. Plank. (Gard. and For. v. 579.)

Celastrus scandens. (Gard. and For. v. 568.) With plate.

Cross Fertilization—Insects attracted by fragrance or brillancy of flowers for purposes of. Richard E. Kunze. (Canad. Entom. 1892; reprint.)

Diatomology. K. M. Cunningham. (Am. Micros. Journ. xiii. 249.)

Diatoms of the Connecticut Shore. W. A. Terry. (Am. Micros. Journ. xiii. 253.)

Die "Springenden Bohnen" aus Mexico—Dritter Beitrag. Franz Buchenau. (Abh. Natur. Ver. Bremen, xii. 577–290.)

Herr Buchenau reviews the whole subject of Mexican "Jumping Beans," holding that *Sebastiana Palmeri,* Rose, the seeds of which contain the larva of *Carpocapsa saltitans* is the same as *S. Pavoniana* Müll. Arg., and that similar seeds are produced by *Colliguaja Brasiliensis* in the Argentine Republic, the "jumping" of these being caused by the larva of another moth, the *Grapholitha motrix.*

Dionœa muscipula, Ellis—Contributions to the History of. J. M. MacFarlane (Contr. Bot. Lab. Univ. Penn. i. 7. illustrated.)

Dr. MacFarlane gives in summary the results of a number of years' experiments upon the plants irrito-contractility. The closure of the leaf is discussed as dependent upon stimuli of mechanical, thermal, luminous, chemical and electrical nature. Experiments show that mechanical stimuli are especially interest-

ing, and demonstrate the peculiar sensitivity of the leaf to a series of irritations, rather than, as generally stated, to the first impulse. A record is given of the plants memory of impulses, and of its memory-duration under varying temperature. A second series of experiments show that closure is not altogether dependent upon irritation of the sensitive hairs, the outer as well as the inner surface of the leaf proving sensitive, but in a less degree. Structurally, the author has especially considered the irritable hairs, and the questions of inter-cellular passages, and of inter-cellular protoplasmic connections. The origin of the contractile impulse is centralized in the joint of the irritable hairs; here a first mechanical impulse coralizes the protoplasmic elements and arranges minute permeable areas in the contained sap,—a second stimulus beginning the process of squeezing out liquid into the permeable areas, and perhaps as well through the hair-joint cells. The discovery of transverse striæ in the cell protoplasm suggests interesting structural relations with striped muscle. The author emphasizes, especially, the important functions of inter-cellular protoplasmic connection and the minor importance of cellulose extensibility. "* * The cellulose membranes are merely secondary strengthening sacs, that act much like the netting bags that surround rubber bellows. * * That contractility, alike in the animal and vegetable kingdoms is accomplished by migration of liquids through the protoplasmic substance, and that this is wholly determined by the molecular condition of the plotoplasm, irrespective of cell walls." The utilization of starch during the process of contraction and secretion is also considered. Experiments in regard to secretion demonstrate that any protoplasmic irritation (including electrical) will cause the outpouring of the digestive juices, a process that becomes as apparently continuous as if a nitrogenous body had been the cause of its excitation. The paper closes with some suggestive notes as to the evolution of the mechanism of *Dionaea*.

BASHFORD DEAN.

Dionæa—An Abnormal Development of the Inflorescence of. John W. Harshberger (Contr. Bot. Lab. Univ. Penn. i. 46, illustrated.

Distribution of the Flora of the Cape Region of Baja California. T. S. Brandegee (Zoe, iii. 223–231).

Epilobium—A New. T. S. Brandegee (Zoe, iii. 242, 243, with plate). Description and figure of *E. niveum* from Snow Mountain, Lake Co., Cal.

Ferns—Synoptical List—xiii. G. S. Jewman (Bull. Bot. Depart. Jamaica, Oct., 1892). Notes on *Hypolepis Purdiana, H. repens, H. nigrescens, Notholæna trichomanoides*, and *N. ferruginea.*

Flora Washingtoniensis. Wilhelm W. Suksdorf (White Salmon, Washington, 1892). A catalogue of the Phænogamia and Pteridophyta of Washington.

Grass of Parnassus (Am. Gard. xiii. 696). Illustration of *Parnassia palustris.*

Leersia—The Genus. Theo. Holm (Bot. Gaz. xvii. 358, reprint, illustrated).

List of Plants collected by C. S. Sheldon and M. A. Carleton in Indian Territory in 1891. J. M. Holzinger (Contr. U. S. Nat. Herb. i. 189). Two new species, *Ipomæa Carletoni* and *Euphorbia strictior*, are described and illustrated.

Nomenclature of Plants. Katharine Brandegee (Zoe, iii. 258–261).

Notes on Collections of Cryptogams from the higher mountains of New England. William G. Farlow (Proc. Bost. Soc. Nat. Hist. xxv. 387).

Notes on the Geology of Skunnemunk Mountain, Orange County, New York. Chas. S. Prosser (Trans. N. Y., Acad. Sci. xi. 132–149).

By far the larger part of this paper is occupied by accounts of the fossil plants found in the rocks of this locallty, by means of which the age has been provisionally determined as Middle Devonian. *Psilophyton princeps*, Daw., was particulary abundant.

Observations on the Plants of Oklahoma Territory and Adjacent Districts. M. A. Carleton (Contr. U. S. Nat. Herb. i. 220).

Œnothera—Notes on Some Species of the Genus. Alice Eastwood (Zoe, iii. 248–252).

On the Myxobacteriaccæ a New Order of Schizomycetes.—Roland Thaxter. (Bot. Gaz. xvii. 389, illustrated).

Two new species of *Chondromyces* are described and illustrated. The genus *Myxobacter* is established with one species *M. aureus.*

The genus *Myxococcus* is also established with three species, *M. rubescens*, *M. virescens*, and *M. coralloides*.

Paleontologie Vegetale. (*Ouvrages publies en 1890.*)—R. Zeiller. (Extrait de l'Annuaire Geologique Universel, vii. 1115–1157).

This is a summary, with comments, upon most of the important publications concerning fossil botany which appeared during the year 1890. America is well represented by the works of Ward, Dawson, Matthew, Fontaine, Knowlton, Holm and others, most of which were here noted at the time of publication.

Pavonia Wrightii. (Meehan's Month. ii. 178).

Pflanzenpathologische Mittheilungen aus Ecuador. G. de Lagerheim. (Zeitsch. Pflanzen. Krank., ii. 195).

Prunus tomentosa. J. G. Jack (Gard. and For. v. 580, with illustration).

Rumfordia from Lower California—A new. T. S. Brandegee (Zoe, iii. 241, 242, with plate).

Discription and figure of *Rumfordia connata.*

Sullivantia Hapemani. J. M. Coulter (Bot. Gaz. xvii, 420).

Tabebuia Donnell-Smithii. J. N. Rose (Bot. Gaz. xvii. 418).

A new species from Mexico and Central America, with one of C. E. Faxon's beautiful plates.

Taxodium mucronatum (Gard. Chron. xii. 646).

With illustration of the famous old Mexican Deciduous Cypress at Sta. Maria del Tulé.

The Occasional Cross. Th. Meehan (Bot. Gaz. xvii. 420).

Trees in Winter. E. P. Powell (Am. Gard. xiii. 706, illustrated).

Two Pretty Pentstemons. F. A. Waugh (Am. Gard. xiii. 724).

Illustrations of *Pentstemon cristatus* and *P. confertus.*

Vegetable Pathology. Report of the Chief of the Division of. (U. S. Depart. Agric., 1892). With illustrations of *Ceratocystis fimbriata.*

Vine Cactus in Mexico—The. (Am. Gard. xiii. 759). Illustration of *Fouquiera splendens.*

Washingtonia filifera. (Gardn. Chron. xii. 590, 677, illustrated).

Weeping Spruce—The. Thomas H. Douglas (Gard. and For. v. 591). With illustration of *Picea Breweriana.*

Wistaria Sinensis—The. Anatomy of the Stem of. Carlton C. Curtiss (Journ. N. Y. Micros. Soc. viii. 79–89; three plates. Reprinted as Contrib. Herb. Col. Coll. No. 28).

Mr. Curtiss describes at length the anatomy of the stem of this vine, with especial reference to the secondary layers of bast which are formed in the growth of old stems at intervals of several years and become covered by the succeeding layers of wood. The material which called especial attention to these studies was received some time ago from Mr. B. Heritage, of Mickleton, N. J.

Reviews of Foreign Literature.

Fossil Plants as Tests of Climate. A. C. Seward. (Pamph. 8vo., pp. 151; Cambridge Univ. Press, London, 1892. New York, Macmillan & Co.) This is the Sedgwick prize essay for the year 1892, and in it the author has endeavored "to consider plants as the thermometers of the past," in which effort he has succeeded in bringing together practically all important references by botanical and geological writers on the subject. Plants in spite of their meagre palæontological remains, as compared with animals, have always been considered as the more trustworthy indices of climatal changes, as they are unable to migrate with the same ease as animals in the event of a change in temperature. They must either perish entirely or else gradually adapt themselves to the changed environment.

An introduction and historical sketch precedes the subject matter proper, after which follow chapters on plant distribution, Arctic vegetation, influence of external conditions upon the macroscopic and microscopic structures of plants, annual rings in recent and fossil plants, Arctic fossil plants, Carboniferous Period, Pleistocene plants and concluding remarks.

The principal question to be solved has always been whether the evidence warranted the assumption of a uniform climate throughout the world in past geological ages or whether there were temperature zones as we recognize them to-day. The general broad view of the subject undoubtedly indicates a uniform tem-

perature until as late as Tertiary times, but several minor facts have recently received attention which would seem to qualify any such general conclusion. The geologists, for instance, insist upon the evidence of the existence of an ice age during the Carboniferous Period, and the present distribution of our alpine and boreal plants prove to be a stumbling block every now and then to those who think that they have reached definite conclusions in regard to plant life and the conditions surrounding it just prior to the Glacial Epoch. In regard to this latter part of the subject—plant distribution—the botanist, has something to learn from the geologist and vice versa, and several errors might have been spared each had they recognized this fact. The subject is one which has received more or less attention lately, and is sure to receive consideration for some time to come, and we earnestly commend some of the references here given to the careful consideration of all who are interested in such discussion.

As a useful compend of diverse views the work is invaluable, and the exhaustive bibliography which is appended will save future students an immense amount of labor. This wealth of reference is confusing, however, especially as the author contributes nothing new in the line of original investigations or conclusions, and the reader is inclined to lay down the work finally with the impression that there is a hopeless disagreement between authorities on the subject of past climatal conditions on the earth as evidenced by plant remains. A. H.

Ueeber Boehmische Kreidepflanzen. Hermann Engelhardt. (Naturforsch. Gesellsch. d. Osterlandes, Neue Folge, Band v. 86–118 Taf. I.)

This supplements in a pleasing manner Velenovsky's work in the same horizon, and adds not a little to our knowledge of the universal vegetation which flourished throughout the world in Cretaceous times. Many species identical with those from the Western Continent may be noted, and the author describes and figures as new *Sphaeroccites Laubei, Litsaea Bohemica, Callistemophyllum Bouderi, Sterculia* sp. (allied to *S. aperta*, Lesqx.) and *Pinus* sp. A. H.